FORM PTO-1390 (Modified) (REV 11-2000) U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEY'S DOCKET NUMBER
112740-386

U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR
10/030339

INTERNATIONAL APPLICATION NO	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/EP00/05198	06 June 2000	29 June 1999

TITLE OF INVENTION
METHOD FOR MONITORING BIT TRANSMISSION QUALITY IN PACKET-MODE TRANSMISSION

APPLICANT(S) FOR DO/EO/US
Joachim Charzinski

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include items (5), (6), (9) and (24) indicated below.
4. ☒ The US has been elected by the expiration of 19 months from the priority date (Article 31).
5. ☒ A copy of the International Application as filed (35 U.S.C. 371 (c) (2))
   a. ☒ is attached hereto (required only if not communicated by the International Bureau).
   b ☐ has been communicated by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☒ An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
   a. ☒ is attached hereto.
   b. ☐ has been previously submitted under 35 U.S.C. 154(d)(4).
7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371 (c)(3))
   a ☐ are attached hereto (required only if not communicated by the International Bureau).
   b. ☐ have been communicated by the International Bureau.
   c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   d. ☒ have not been made and will not be made.
8. ☐ An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371 (c)(4)).
10. ☐ An English language translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371 (c)(5)).
11. ☒ A copy of the International Preliminary Examination Report (PCT/IPEA/409).
12. ☒ A copy of the International Search Report (PCT/ISA/210).

Items 13 to 20 below concern document(s) or information included:

13. ☒ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
14. ☒ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
15. ☒ A **FIRST** preliminary amendment.
16. ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
17. ☒ A substitute specification.
18. ☐ A change of power of attorney and/or address letter.
19. ☐ A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821 - 1.825.
20. ☐ A second copy of the published international application under 35 U.S.C. 154(d)(4).
21. ☐ A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).
22. ☒ Certificate of Mailing by Express Mail
23. ☐ Other items or information:

PCTUS1/REV03

U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR)	INTERNATIONAL APPLICATION NO.	ATTORNEY'S DOCKET NUMBER
10/030339	PCT/EP00/05198	112740486

JC10 Rec'd PCT/PTO 27 DEC 2001

4. The following fees are submitted:.	CALCULATIONS PTO USE ONLY
BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) :	
☐ Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO **$1040.00**	
☒ International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO **$890.00**	
☐ International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO **$740.00**	
☐ International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4) **$710.00**	
☐ International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4) **$100.00**	
ENTER APPROPRIATE BASIC FEE AMOUNT =	**$890.00**
Surcharge of **$130.00** for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492 (e)).	**$0.00**

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total claims	9 - 20 =	0	x $18.00	**$0.00**	
Independent claims	1 - 3 =	0	x $84.00	**$0.00**	
Multiple Dependent Claims **(check if applicable)**.			☐	**$0.00**	
TOTAL OF ABOVE CALCULATIONS			=	**$890.00**	
☐ Applicant claims small entity status. See 37 CFR 1.27). The fees indicated above are reduced by 1/2.				**$0.00**	
SUBTOTAL			=	**$890.00**	
Processing fee of **$130.00** for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492 (f)).			+	**$0.00**	
TOTAL NATIONAL FEE			=	**$890.00**	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31) **(check if applicable).**			☐	**$0.00**	
TOTAL FEES ENCLOSED			=	**$890.00**	
				Amount to be: refunded	$
				charged	$

a. ☒ A check in the amount of **$890.00** to cover the above fees is enclosed.

b. ☐ Please charge my Deposit Account No. _____ in the amount of _____ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. **02-1818** A duplicate copy of this sheet is enclosed.

d. ☐ Fees are to be charged to a credit card. **WARNING:** Information on this form may become public. **Credit card information should not be included on this form.** Provide credit card information and authorization on PTO-2038.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

William E. Vaughan (Reg. No. 39,056)
Bell, Boyd & Lloyd LLC
P.O. Box 1135
Chicago, Illinois 60690-1135

SIGNATURE

William E. Vaughan
NAME

39,056
REGISTRATION NUMBER

December 27, 2001
DATE

BOX PCT

IN THE UNITED STATES ELECTED/DESIGNATED OFFICE
OF THE UNITED STATES PATENT AND TRADEMARK OFFICE
UNDER THE PATENT COOPERATION TREATY-CHAPTER II

PRELIMINARY AMENDMENT

APPLICANT:	Joachim Charzinski	DOCKET NO.:	112740-386
SERIAL NO:		GROUP ART UNIT:	
FILED:		EXAMINER:	
INTERNATIONAL APPLICATION NO::		PCT/EP00/05198	
INTERNATIONAL FILING DATE		06 June 2000	
INVENTION:	METHOD FOR MONITORING BIT TRANSMISSION QUALITY IN PACKET-MODE TRANSMISSION		

Assistant Commissioner for Patents,
Washington, D.C. 20231

Sir:

Please amend the above-identified International Application before entry into the National stage before the U.S. Patent and Trademark Office under 35 U.S.C. §371 as follows:

In the Specification:

Please replace the Specification of the present application, including the Abstract, with the following Substitute Specification:

SPECIFICATION

TITLE OF THE INVENTION

METHOD FOR MONITORING BIT TRANSMISSION QUALITY
IN PACKET-MODE TRANSMISSION

BACKGROUND OF THE INVENTION

In contemporary information processing systems, information is transmitted in IP (Internet Protocol) packets. This is connectionless switching by which no permanent connection is established between the transmitting facility and the receiving facility.

To be able to recognize transmission errors, each packet is provided with a checksum. This checksum can be used for determining bit errors at the receiving end. The checksum is calculated, for example, over all the information transmitted between two reference points. For example, two switching nodes can act as reference points between which a transmission section formed of a multiplicity of subsections is arranged. The subsections are formed by regenerative repeaters arranged on the transmission section.

The checksum is calculated both in the transmitting switching node and in the receiving switching node independently of one another. During this process, e.g., a CRC calculation is carried out at the transmitting end and is included in the packet to be transmitted. At the receiving end, this checksum, which is also transmitted, is evaluated and compared with the calculation of another checksum formed from the received information. If this comparison results in a difference, the received packet is discarded.

Using this procedure, it is thus possible to detect transmission errors on the entire transmission section; i.e., between the two switching nodes. It is not possible to use this procedure to determine the rate of transmission errors section by section which is required in many cases.

The present invention is, therefore, directed toward demonstrating an approach as to how the bit transmission quality can be efficiently monitored section by section even in the case of connectionless switching.

SUMMARY OF THE INVENTION

An advantageous factor in the present invention is, in particular, that it is possible to detect the bit errors which have occurred during the transmission process section-by-section whereas the checksum method used in the prior art only allows an end-to-end statement. For this purpose, a second check information item is formed by an algorithm in a transmitting regenerative repeater over this information and, possibly, other information of the packet to be sent out. The second check information item is also included in the packet and is only evaluated in the receiving regenerative repeater and compared with a check information item formed here in accordance with the same further algorithm.

Indeed, in an embodiment of the present invention, a method is provided for monitoring bit transmission quality in packet-mode transmission, which includes the steps of: supplying information in packets, via a transmitting device, in accordance with connectionless switching to a receiving device via a transmission section having a number of transmission devices; forming a first check information item in the transmitting device by an algorithm in the transmitting device over the information of a packet to be sent out, the check information item being included in the packet; comparing the check information item, on arrival of the packet in the receiving device, with a check information item formed in the receiving device in accordance with the same algorithm; forming a second check information item over the information of the packet to be sent out and, possibly, over other information in accordance with a further algorithm in one of the transmitting device and the transmitting transmission device, the second check information item being included in the packet; evaluating the second check information item in one of the receiving device and a receiving transmission device; and comparing the second check information item with a check information item formed in the respective one of the receiving device and the receiving transmission device in accordance with the further algorithm.

Additional features and advantages of the present invention are described in, and will be apparent from, the following Detailed Description of the Invention and the Figures.

BRIEF DESCRIPTION OF THE FIGURES

Figure 1 shows 2 switching nodes which terminate a transmission section.

Figure 2 shows the frame structure into which IP packets are inserted during transmission.

DETAILED DESCRIPTION OF THE INVENTION

Figure 1 shows a configuration in which the method according to the present invention is executed. Accordingly, two switching nodes R_A, R_B are shown which terminate a transmission section UA. Between the switching nodes R_A, R_B, a multiplicity of regenerative repeaters $RG_1 \ldots RG_n$ are arranged in the transmission section UA. Two of these regenerative repeaters terminate each subsection TA, the

entire transmission section UA being formed of these subsections TA. According to the present exemplary embodiment, the switching nodes R_A, R_B are to be constructed as IP routers.

It is also assumed that IP packets are conducted via the transmission section UA with the aid of the WDM (wave division multiplexing) transmission method. According to the present exemplary embodiment, it is also assumed that the transmitting switching node is the IP router R_A and the receiving switching node is the IP router R_B. The transmitting IP router R_A transmits IP packets of different length via the transmission section UA to the receiving IP router R_B. The transmission section UA is bidirectional but, for better understanding, only the transmission from the transmitting IP router R_A to the receiving IP router R_B is shown.

Figure 2 shows how the IP packets are sent via the transmission section UA. Accordingly, an IP packet is incorporated (encapsulated) in a frame structure R in the IP router R_A. For this purpose, the IP packet is inserted into a payload packet field NP. This is preceded by a frame header RK. In this header, information on, e.g., the beginning of the frame and the length of the frame is stored. Furthermore, a field for error detection FE is provided in which the result of checksum calculations is stored. Checksum calculations used can be, for example, CRC check sequences. These check sequences are generated in the IP router R_A and evaluated in the IP router R_B (end to end). Thus, a statement can be made here on the transmission quality of the entire transmission section UA arranged between the IP router R_A and the IP router R_B and defective packets can be detected and discarded.

According to the present invention, an additional parity field PM is provided in which parity bits P are transmitted. The parity bits P are determined in the transmitting regenerative repeater, for example in accordance with the BIP (bit interleaved parity) calculation method, and supplied in the parity field PM to the regenerative repeater arranged at the receiving end via the relevant subsection TA. The parity bits P are transmitted in each payload frame in the parity field PM and are calculated within the frame R either only for the payload packet NP, for the

payload packet NP together with the checksum FE, or for the payload packet NP together with the checksum FE and the frame header RK. When the width of the parity field PM is 1 bit, a single parity bit can be used for the calculation.

In the regenerative repeater arranged at the receiving end, the parity bits P are evaluated and compared with a separate parity evaluation performed here. From the result, the parity bit P is newly set and entered in the parity field PM. Furthermore, statistics kept in the receiving regenerative repeater about transmission errors which have occurred are updated.

Since multiple errors can cancel each other in the parity bits P, the number of bit errors which have occurred on a transmission section are estimated in accordance with the maximum likelihood method as the number of bits in which the separate calculation of the parity bits P of a regenerative repeater differs from the received parity bits. The instantaneous bit error rate is assumed as the quotient of the estimation for the number of bit errors which have occurred divided by the number of bits in the transmitted frame. An estimate of the bit error rate which is quite adequate for performance monitoring purposes is obtained by averaging a number of successive instantaneous estimates.

This procedure enables a bit error rate estimate to be performed section-by-section. The section-related bit error rate estimates stored in the individual regenerative repeaters can then be read out, for example, via X.25 protocols.

Although the present invention has been described with reference to specific embodiments, those of skill in the art will recognize that changes may be made thereto without departing from the spirit and scope of the invention as set forth in the hereafter appended claims.

ABSTRACT OF THE DISCLOSURE

A method for monitoring bit transmission quality in packet-mode transmission wherein, in connectionless switching as represented by IP packet switching, each packet is provided with a checksum for monitoring the bit transmission quality. At the receiving end, this checksum can be used only for stating that a transmission error has occurred somewhere in the entire transmission section (end-to-end). To detect the bit errors, which have occurred during the transmission process, section-by-section, another check information item is formed which is included in the packet.

In the Claims:

On page 13, cancel line 1 and substitute the following left-hand justified heading therefore:

CLAIMS

Please cancel the claims 1-9, without prejudice, and substitute the following claims therefore:

10. A method for monitoring bit transmission quality in packet-mode transmission, the method comprising the steps of:

supplying information in packets, via a transmitting device, in accordance with connectionless switching to a receiving device via a transmission section having a plurality of transmission devices;

forming a first check information item in the transmitting device by an algorithm in the transmitting device over the information of a packet to be sent out, the check information item being included in the packet;

comparing the check information item, on arrival of the packet in the receiving device, with a check information item formed in the receiving device in accordance with the same algorithm;

forming a second check information item over the information of the packet to be sent out and, possibly, over other information in accordance with a further algorithm in one of the transmitting device and a transmitting transmission device, the second check information item being included in the packet;

evaluating the second check information item in one of the receiving device and a receiving transmission device; and

comparing the second check information item with a check information item formed in the respective one of the receiving device and the receiving transmission device in accordance with the further algorithm.

11. A method for monitoring bit transmission quality in packet-mode transmission as claimed in Claim 10, the method further comprising the step of:

providing a frame structure for the transmission of the packets via the transmission section, in which the packet, a frame header and the first and second check items are stored.

12. A method for monitoring bit transmission quality in packet-mode transmission as claimed in Claim 10, the method further comprising the step of:

determining the transmission quality of the entire transmission section by evaluating the first check information item at the receiving end.

13. A method from monitoring bit transmission quality in packet-mode transmission as claimed in Claim 10, the method further comprising the step of:

determining the transmission quality of individual subsections by evaluating the second check information item at the receiving end.

14. A method for monitoring bit transmission quality in packet-mode transmission as claimed in Claim 10, wherein the further information is at least one of the frame header and the first check information item.

15. A method for monitoring bit transmission quality in packet-mode transmission as claimed in Claim 10, wherein the packets transmit information in accordance with an Internet Protocol.

16. A method for monitoring bit-transmission quality in packet-mode transmission as claimed in Claim 10, the method further comprising the step of:

producing the second check information item by a Bit Interleaved Parody calculation.

17. A method for monitoring bit transmission quality in packet-mode transmission as claimed in Claim 10, wherein the transmitting and receiving devices are constructed as switching nodes.

18. A method for monitoring bit transmission quality in packet-mode transmission as claimed in Claim 10, wherein the transmission devices are constructed as regenerative repeaters.

REMARKS

The present amendment makes editorial changes and corrects typographical errors in the specification, which includes the Abstract, in order to conform the specification to the requirements of United States Patent Practice. No new matter is added thereby. Attached hereto is a marked-up version of the changes made to the specification by the present amendment. The attached page is captioned "**Version With Markings To Show Changes Made**".

In addition, the present amendment cancels original claims 1-9 in favor of new claims 10-18. Claims 10-18 have been presented solely because the revisions by red-lining and underlining which would have been necessary in claims 1-9 in order to present those claims in accordance with preferred United States Patent Practice would have been too extensive, and thus would have been too burdensome. The present amendment is intended for clarification purposes only and not for substantial reasons related to patentability pursuant to 35 U.S.C. §§101, 102, 103 or 112. Indeed, the cancellation of claims 1-9 does not constitute an intent on the part of the Applicants to surrender any of the subject matter of claims 1-9.

Early consideration on the merits is respectfully requested.

Respectfully submitted,

(Reg. No. 39,056)

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VERSIONS WITH MARKINGS TO SHOW CHANGES MADE

In The Specification:

The Specification of the present application, including the Abstract, has been amended as follows:

~~Description~~

SPECIFICATION

~~Method for monitoring the bit transmission quality in packet-mode transmission~~

TITLE OF THE INVENTION

METHOD FOR MONITORING BIT TRANSMISSION QUALITY

IN PACKET-MODE TRANSMISSION

~~The invention relates to a method as claimed in the preamble of patent claim 1.~~

BACKGROUND OF THE INVENTION

In contemporary information processing systems, information is transmitted in IP (Internet Protocol) packets. This is connectionless switching by ~~means of~~ which no permanent connection is established between the transmitting facility and the receiving facility.

To be able to recognize transmission errors, each packet is provided with a checksum. This checksum can be used for determining bit errors at the receiving end. The checksum is calculated, for example, over all the information transmitted between two reference points. For example, two switching nodes can act as reference points between which a transmission section formed of a multiplicity of subsections is arranged. The subsections are formed by regenerative repeaters arranged on the transmission section.

The checksum is calculated both in the transmitting switching node and in the receiving switching node independently of one another. During this process, e.g., a CRC calculation is carried out at the transmitting end~~,~~ and is included in the packet to be transmitted. At the receiving end, this checksum, which is also transmitted, is evaluated and compared with the calculation of another checksum formed from the received information. If this comparison results in a difference, the received packet is discarded.

Using this procedure, it is thus possible to detect transmission errors on the entire transmission section~~;~~, i.e., between the two switching nodes. It is not possible to use this procedure to determine the rate of transmission errors section by section which is required in many cases.

The present invention is ~~based on the object of~~, therefore, directed toward demonstrating an approach as to how the bit transmission quality can be efficiently monitored section by section even in the case of connectionless switching.

~~The invention is achieved, on the basis of the preamble of patent claim 1, by the features specified in the characterizing clause.~~

SUMMARY OF THE INVENTION

~~The~~ An advantageous factor in the present invention is, in particular, that it is possible to detect the bit errors which have occurred during the transmission process section-by-section whereas the checksum method used in the prior art only allows an end-to-end statement. For this purpose, a second check information item is formed by an algorithm in a transmitting regenerative repeater over this information and, possibly, other information of the packet to be sent out~~, which~~. The second check information item is also included in the packet and is only evaluated in the receiving regenerative repeater and compared with a check information item formed here in accordance with the same further algorithm.

~~Advantageous further developments of the invention are provided in the subclaims.~~

Indeed, in an embodiment of the present invention, a method is provided for monitoring bit transmission quality in packet-mode transmission, which includes the steps of: supplying information in packets, via a transmitting device, in accordance with connectionless switching to a receiving device via a transmission section having a number of transmission devices; forming a first check information item in the transmitting device by an algorithm in the transmitting device over the information of a packet to be sent out, the check information item being included in the packet; comparing the check information item, on arrival of the packet in the receiving device, with a check information item formed in the receiving device in accordance with the same algorithm; forming a second check information item over

the information of the packet to be sent out and, possibly, over other information in accordance with a further algorithm in one of the transmitting device and the transmitting transmission device, the second check information item being included in the packet; evaluating the second check information item in one of the receiving device and a receiving transmission device; and comparing the second check information item with a check information item formed in the respective one of the receiving device and the receiving transmission device in accordance with the further algorithm.

~~In the text which follows, the invention will be explained in greater detail with reference to an exemplary embodiment.~~

Additional features and advantages of the present invention are described in, and will be apparent from, the following Detailed Description of the Invention and the Figures.

BRIEF DESCRIPTION OF THE FIGURES

Figure 1 shows 2 switching nodes which terminate a transmission section~~, and~~.

Figure 2 shows the frame structure into which IP packets are inserted during transmission.

DETAILED DESCRIPTION OF THE INVENTION

Figure 1 shows a configuration in which the method according to the present invention is executed. Accordingly, two switching nodes R_A, R_B are shown which terminate a transmission section UA. Between the switching nodes R_A, R_B, a multiplicity of regenerative repeaters $RG_1 \ldots RG_n$ are arranged in the transmission section UA. Two of these regenerative repeaters terminate each subsection TA, the entire transmission section UA being formed of these subsections TA. According to the present exemplary embodiment, the switching nodes R_A, R_B are to be constructed as IP routers.

It is also assumed that IP packets are conducted via the transmission section UA with the aid of the WDM (wave division multiplexing) transmission method. According to the present exemplary embodiment, it is also assumed that the transmitting switching node is the IP router R_A and the receiving switching node is

the IP router R_B. The transmitting IP router R_A transmits IP packets of different length via the transmission section UA to the receiving IP router R_B. The transmission section UA is bidirectional but, for better understanding, only the transmission from the transmitting IP router R_A to the receiving IP router R_B is shown.

Figure 2 shows how the IP packets are sent via the transmission section UA. Accordingly, an IP packet is incorporated (encapsulated) in a frame structure R in the IP router R_A. For this purpose, the IP packet is inserted into a payload packet field NP. This is preceded by a frame header RK. In this header, information on, e.g., the beginning of the frame and the length of the frame is stored. Furthermore, a field for error detection FE is provided in which the result of checksum calculations is stored. Checksum calculations used can be, for example, CRC check sequences. These check sequences are generated in the IP router R_A and evaluated in the IP router R_B (end to end). Thus, a statement can be made here on the transmission quality of the entire transmission section UA arranged between the IP router R_A and the IP router R_B and defective packets can be detected and discarded.

According to the present invention, an additional parity field PM is provided in which parity bits P are transmitted. The parity bits P are determined in the transmitting regenerative repeater, for example in accordance with the BIP (bit interleaved parity) calculation method, and supplied in the parity field PM to the regenerative repeater arranged at the receiving end via the relevant subsection TA. The parity bits P are transmitted in each payload frame in the parity field PM and are calculated within the frame R either only for the payload packet NP, for the payload packet NP together with the checksum FE, or for the payload packet NP together with the checksum FE and the frame header RK. When the width of the parity field PM is 1 bit, a single parity bit can be used for the calculation.

In the regenerative repeater arranged at the receiving end, the parity bits P are evaluated and compared with a separate parity evaluation performed here. From the result, the parity bit P is newly set and entered in the parity field PM.

Furthermore, statistics kept in the receiving regenerative repeater about transmission errors which have occurred are updated.

Since multiple errors can cancel each other in the parity bits P, the number of bit errors which have occurred on a transmission section are estimated in accordance with the maximum likelihood method as the number of bits in which the separate calculation of the parity bits P of a regenerative repeater differs from the received parity bits. The instantaneous bit error rate is assumed as the quotient of the estimation for the number of bit errors which have occurred divided by the number of bits in the transmitted frame. An estimate of the bit error rate which is quite adequate for performance monitoring purposes is obtained by averaging a number of successive instantaneous estimates.

This procedure enables a bit error rate estimate to be performed section-by-section. The section-related bit error rate estimates stored in the individual regenerative repeaters can then be read out, for example, via X.25 protocols.

Although the present invention has been described with reference to specific embodiments, those of skill in the art will recognize that changes may be made thereto without departing from the spirit and scope of the invention as set forth in the hereafter appended claims.

~~Method for monitoring the bit transmission quality in packet-mode transmission~~

ABSTRACT OF THE DISCLOSURE

A method for monitoring bit transmission quality in packet-mode transmission wherein, in ~~In~~ connectionless switching as represented by IP packet switching, each packet is provided with a checksum for monitoring the bit transmission quality. At the receiving end, this checksum can be used only for stating that a transmission error has occurred somewhere in the entire transmission section (end-to-end). ~~It is not possible, however, to~~ To detect the bit errors, which have occurred during the transmission process, section-by-section~~. To solve this problem~~, another check information item is formed which is included in the packet.

(12) NACH DEM VERTRAG ÜBER DIE INTERNATIONALE ZUSAMMENARBEIT AUF DEM GEBIET DES PATENTWESENS (PCT) VERÖFFENTLICHTE INTERNATIONALE ANMELDUNG

(19) Weltorganisation für geistiges Eigentum
Internationales Büro

(43) Internationales Veröffentlichungsdatum
11. Januar 2001 (11.01.2001)

PCT

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(22) Internationales Anmeldedatum:
6. Juni 2000 (06.06.2000)

(25) Einreichungssprache: Deutsch

(26) Veröffentlichungssprache: Deutsch

(30) Angaben zur Priorität:
99112406.6 29. Juni 1999 (29.06.1999) EP

(71) Anmelder *(für alle Bestimmungsstaaten mit Ausnahme von US)*: SIEMENS AKTIENGESELLSCHAFT [DE/DE]; Wittelsbacherplatz 2, D-80333 München (DE).

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(81) Bestimmungsstaaten *(national)*: CA, US.

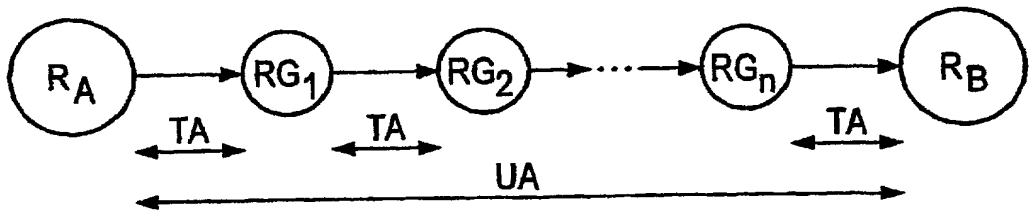
(84) Bestimmungsstaaten *(regional)*: europäisches Patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

Veröffentlicht:
— *Mit internationalem Recherchenbericht.*

Zur Erklärung der Zweibuchstaben-Codes, und der anderen Abkürzungen wird auf die Erklärungen ("Guidance Notes on Codes and Abbreviations") am Anfang jeder regulären Ausgabe der PCT-Gazette verwiesen.

(54) Title: METHOD FOR MONITORING THE BIT TRANSMISSION QUALITY IN PACKET-ORIENTATED TRANSMISSION

(54) Bezeichnung: VERFAHREN ZUR ÜBERWACHUNG DER BITÜBERTRAGUNGSGÜTE BEI PAKETORIENTIERTER ÜBERTRAGUNG



(57) Abstract: During a connectionless switching, as depicted in an IP packet switching, each packet is provided with a checksum for monitoring the bit transmission quality. With the aid of this checksum, only one statement can be made on the side of reception that a transmission error has occurred on the entire transmission section (end-to-end). It is no longer possible to carry out a section-by-section detection of the bit errors that occur during the transmission process. In order to rectify this problem, an additional piece of check information is formed which accompanies the packet.

(57) Zusammenfassung: Bei einer verbindungslosen Verm ittlung, wie sie eine IP-Paketvermittlung darstellt, wird zur Überwachung der Bitübertragungsgüte jedes Paket mit einer Prüfsumme versehen. Mit Hilfe dieser Prüfsumme kann empfangsseitig lediglich eine Aussage darüber getroffen werden, daß auf dem gesammten Übertragungsabschnitt (end-to-end) ein Übertragungsfehler aufgetreten ist. Ein abschnittsweises Erfassen der während des Übertragungsvorganges aufgetretenen Bitfehler ist aber nicht möglich. Zur Lösung dieses Problems wird eine weitere Prüfinformation gebildet, die dem Paket mitgegeben wird.

WO 01/03361 A1

Description

Method for monitoring the bit transmission quality in packet-mode transmission

The invention relates to a method as claimed in the preamble of patent claim 1.

In contemporary information processing systems, information is transmitted in IP (Internet Protocol) packets. This is connectionless switching by means of which no permanent connection is established between the transmitting facility and the receiving facility.

To be able to recognize transmission errors, each packet is provided with a checksum. This checksum can be used for determining bit errors at the receiving end. The checksum is calculated, for example, over all the information transmitted between two reference points. For example, two switching nodes can act as reference points between which a transmission section formed of a multiplicity of subsections is arranged. The subsections are formed by regenerative repeaters arranged on the transmission section.

The checksum is calculated both in the transmitting switching node and in the receiving switching node independently of one another. During this process, e.g. a CRC calculation is carried out at the transmitting end, and is included in the packet to be transmitted. At the receiving end, this checksum, which is also transmitted, is evaluated and compared with the calculation of another checksum formed from the received information. If this comparison results in a difference, the received packet is discarded.

Using this procedure, it is thus possible to detect transmission errors on the entire transmission section, i.e. between the two

switching nodes. It is not possible to use this procedure to determine the rate of transmission errors section by section which is required in many cases.

The invention is based on the object of demonstrating an approach as to how the bit transmission quality can be efficiently monitored section by section even in the case of connectionless switching.

The invention is achieved, on the basis of the preamble of patent claim 1, by the features specified in the characterizing clause.

The advantageous factor in the invention is, in particular, that it is possible to detect the bit errors which have occurred during the transmission process section by section whereas the checksum method used in the prior art only allows an end-to-end statement. For this purpose, a second check information item is formed by an algorithm in a transmitting regenerative repeater over this information and possibly other information of the packet to be sent out, which second check information item is also included in the packet and is only evaluated in the receiving regenerative repeater and compared with a check information item formed here in accordance with the same further algorithm.

Advantageous further developments of the invention are provided in the subclaims.

In the text which follows, the invention will be explained in greater detail with reference to an exemplary embodiment.

Figure 1 shows 2 switching nodes which terminate a transmission section, and

Figure 2 shows the frame structure into which IP packets are inserted during transmission.

Figure 1 shows a configuration in which the method according to the invention is executed. Accordingly, two switching nodes R_A, R_B are shown which terminate a transmission section UA. Between the switching nodes R_A, R_B, a multiplicity of regenerative repeaters $RG_1 \ldots RG_n$ are arranged in the transmission section UA. Two of these regenerative repeaters terminate each subsection TA, the entire transmission section UA being formed of these subsections TA. According to the present exemplary embodiment, the switching nodes R_A, R_B are to be constructed as IP routers.

It is also assumed that IP packets are conducted via the transmission section UA with the aid of the WDM (wave division multiplexing) transmission method. According to the present exemplary embodiment, it is also assumed that the transmitting switching node is the IP router R_A and the receiving switching node is the IP router R_B. The transmitting IP router R_A transmits IP packets of different length via the transmission section UA to the receiving IP router R_B. The transmission section UA is bidirectional but, for better understanding, only the transmission from the transmitting IP router R_A to the receiving IP router R_B is shown.

Figure 2 shows how the IP packets are sent via the transmission section UA. Accordingly, an IP packet is incorporated (encapsulated) in a frame structure R in the IP router R_A. For this purpose, the IP packet is inserted into a payload packet field NP. This is preceded by a frame header RK. In this header, information on, e.g. the beginning of the frame and the length of the frame is stored. Furthermore, a field for error detection FE is provided in which the result of

checksum calculations is stored. Checksum calculations used can be, for example, CRC check sequences. These check sequences

are generated in the IP router R_A and evaluated in the IP router R_B (end to end). Thus, a statement can be made here on the transmission quality of the entire transmission section UA arranged between the IP router R_A and the IP router R_B and defective packets can be detected and discarded.

According to the invention, an additional parity field PM is provided in which parity bits P are transmitted. The parity bits P are determined in the transmitting regenerative repeater, for example in accordance with the BIP (bit interleaved parity) calculation method and supplied in the parity field PM to the regenerative repeater arranged at the receiving end via the relevant subsection TA. The parity bits P are transmitted in each payload frame in the parity field PM and are calculated within the frame R either only for the payload packet NP, for the payload packet NP together with the checksum FE, or for the payload packet NP together with the checksum FE and the frame header RK. When the width of the parity field PM is 1 bit, a single parity bit can be used for the calculation.

In the regenerative repeater arranged at the receiving end, the parity bits P are evaluated and compared with a separate parity evaluation performed here. From the result, the parity bit P is newly set and entered in the parity field PM. Furthermore, statistics kept in the receiving regenerative repeater about transmission errors which have occurred are updated.

Since multiple errors can cancel each other in the parity bits P, the number of bit errors which have occurred on a transmission section are estimated in accordance with the maximum likelihood method as the number of bits in which the separate calculation of the parity bits P of a regenerative repeater differs from the received parity bits. The instantaneous bit error

rate is assumed as the quotient of the estimation for the number

of bit errors which have occurred divided by the number of bits in the transmitted frame. An estimate of the bit error rate which is quite adequate for performance monitoring purposes is obtained by averaging a number of successive instantaneous estimates.

This procedure enables a bit error rate estimate to be performed section by section. The section-related bit error rate estimates stored in the individual regenerative repeaters can then be read out, for example, via X.25 protocols.

Patent Claims

1. A method for monitoring the bit transmission quality in packet-mode transmission, comprising

a transmitting device (R_A), by which information in packets is supplied in accordance with connectionless switching to a receiving device (R_B) via a transmission section (UA) having a multiplicity of transmission devices ($RG_1 \ldots RG_n$), in which a first check information item (FE) is formed by an algorithm in the transmitting device (R_A) over the information of the packet to be sent out, which check information item is included in the packet and, on arrival of the packet in the receiving device (R_B), is compared with a check information item formed here in accordance with the same algorithm, characterized in that a second check information item (P) is formed over the information of the packet to be sent out and possibly other information in accordance with another algorithm in the transmitting device (R_A) or a transmitting transmission device ($RG_1 \ldots RG_n$), which second check information item is also included in the packet and is also evaluated in the receiving device (R_B) or in a receiving transmission device ($RG_1 \ldots RG_n$) and compared with a check information item formed here in accordance with the same further algorithm.

2. The method as claimed in claim 1, characterized in that for the transmission of the packets via the transmission section (UA), a frame structure (R) is provided in which the packet (IP), a frame header (RK) and the first (FE) and second check information items (P) are stored.

3. The method as claimed in claim 1, 2, characterized in that

the transmission quality of the entire transmission section (UA) is determined by the evaluation of the first check information item (FE) at the receiving end.

4. The method as claimed in claim 1, 2, characterized in that the transmission quality of the individual subsections (TA) is determined by the evaluation of the second check information item (P) at the receiving end.

5. The method as claimed in claim 1 to 4, characterized in that the further information is the frame header (RK) and/or the first check information item (FE).

6. The method as claimed in claim 1 to 5, characterized in that the packets transmit information in accordance with an Internet Protocol (IP packets).

7. The method as claimed in one of the preceding claims, characterized in that the second check information item (P) is produced by a BIP (bit interleaved parity) calculation.

8. The method as claimed in one of the preceding claims, characterized in that the transmitting (R_A) and receiving (R_B) devices are constructed as switching nodes.

9. The method as claimed in one of the preceding claims, characterized in that the transmission devices are constructed as regenerative repeaters ($RG_1 \ldots RG_n$).

FIG 1

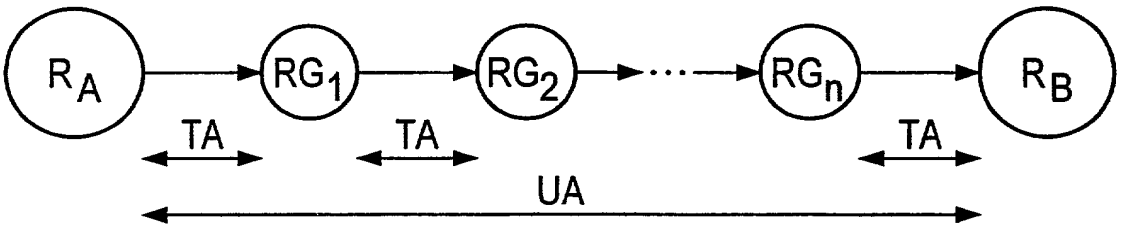
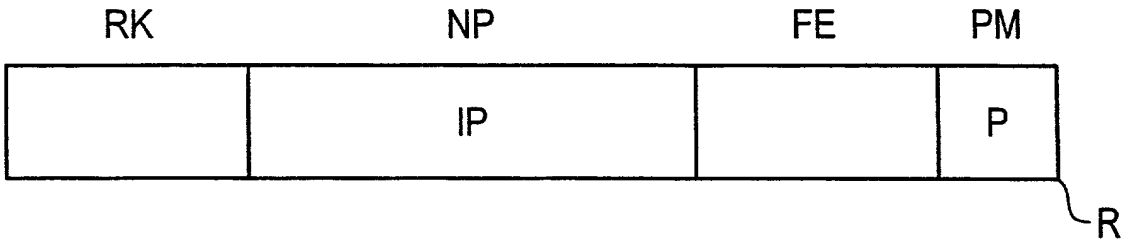


FIG 2



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Erklärung Für Patentanmeldungen Mit Vollmacht
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My residence, post office address and citizenship are as stated below next to my name,

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I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

VERFAHREN ZUR ÜBERWACHUNG DER BITÜBERTRAGUNGSGÜTE BEI PAKETORINTIERTER ÜBERTRAGUNG

METHOD FOR MONITORING THE BIT TRANSMISSION QUALITY IN PACKET-ORIENTATED TRANSMISSION

deren Beschreibung

(zutreffendes ankreuzen)
☐ hier beigefügt ist.
☒ am 06.06.2000 als
PCT internationale Anmeldung
PCT Anmeldungsnummer PCT/EP00/05198
eingereicht wurde und am _____
abgeändert wurde (falls tatsächlich abgeändert).

the specification of which

(check one)
☐ is attached hereto.
☒ was filed on 06.06.2000 as
PCT international application
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I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56(a).

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Prior foreign appplications
Priorität beansprucht

			Priority Claimed	
99112406.6	EP	29.06.1999	☒	☐
(Number) (Nummer)	(Country) (Land)	(Day Month Year Filed) (Tag Monat Jahr eingereicht)	Yes Ja	No Nein
			☐	☐
(Number) (Nummer)	(Country) (Land)	(Day Month Year Filed) (Tag Monat Jahr eingereicht)	Yes Ja	No Nein
			☐	☐
(Number) (Nummer)	(Country) (Land)	(Day Month Year Filed) (Tag Monat Jahr eingereicht)	Yes Ja	No Nein

Ich beanspruche hiermit gemäss Absatz 35 der Zivilprozessordnung der Vereinigten Staaten, Paragraph 120, den Vorzug aller unten aufgeführten Anmeldungen und falls der Gegenstand aus jedem Anspruch dieser Anmeldung nicht in einer früheren amerikanischen Patentanmeldung laut dem ersten Paragraphen des Absatzes 35 der Zivilprozeßordnung der Vereinigten Staaten, Paragraph 122 offenbart ist, erkenne ich gemäss Absatz 37, Bundesgesetzbuch, Paragraph 1.56(a) meine Pflicht zur Offenbarung von Informationen an, die zwischen dem Anmeldedatum der früheren Anmeldung und dem nationalen oder PCT internationalen Anmeldedatum dieser Anmeldung bekannt geworden sind.

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PCT/EP00/05198 (Application Serial No.) (Anmeldeseriennummer)	06.06.2000 (Filing Date D, M, Y) (Anmeldedatum T, M, J)	anhängig (Status) (patentiert, anhängig, aufgegeben)	pending (Status) (patented, pending, abandoned)
_____ (Application Serial No.) (Anmeldeseriennummer)	(Filing Date D,M,Y) (Anmeldedatum T, M; J)	_____ (Status) (patentiert, anhängig, aufgeben)	(Status) (patented, pending, abandoned)

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Unterschrift des Erfinders Datum	Second Inventor's signature Date
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